ADMINISTRATIVE NOTE:
NEW REQUIREMENTS/PROCEDURES

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BAA 04-29 PROPOSER INFORMATION PAMPHLET

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The Defense Advanced Research Projects Agency (DARPA) often selects its research efforts through the Broad Agency Announcement (BAA) process. The BAA will be posted directly to FedBizOpps.gov, the single government point-of-entry (GPE) for Federal government procurement opportunities over $25,000. The following information is for those wishing to respond to the Broad Agency Announcement.

Coordination Decision Support Assistants (COORDINATORs), SOL BAA 04-29, Proposals Due: Initial Closing: August 23, 2004, Final Closing: June 1, 2005, POC: Dr. Tom Wagner, DARPA/IPTO; FAX: (703) 741-7804

PROGRAM OBJECTIVES AND DESCRIPTION.

Introduction

The Defense Advanced Research Projects Agency (DARPA) Information Processing Technology Office (IPTO) is soliciting proposals for Coordination Decision Support Assistants (COORDINATORs), a new program to develop software coordination managers that provide coordination support to humans. The goal of COORDINATORs is to help fielded human units (e.g., soldiers, tactical teams) adapt their mission plans online in response to change. Coordination support will enable fielded units to respond more rapidly and more accurately to the dynamics of the situation while incurring less cognitive load and performing with a greater degree of coordinated action.

There are five primary technical areas in this program: distributed activity coordination, context-dependent coordination autonomy, machine learning, organizational reasoning, and meta-cognition. Hard research problems include distributed coordination over large interconnected mission structures that change dynamically, supporting coordination of large-scale operations where units may have roles in multiple missions, learning to support the units better by automating decision making when data is potentially sparse, responding in (fast enough) "real time" to change, and reasoning about military decision-making policies and procedures during coordination.

The program is expected to have four 12-month phases. Only Phase I will be funded initially. DARPA will host an Industry Day for the COORDINATORs program on July 14, 2004. For more details and registration information please go to http://www.darpa.mil/ipto/Solicitations/solicitations.htm. Additional BAA details follow.

Placement and Motivation

The focus of the program is to create distributed intelligent computational systems that adapt existing mission plans online, in real time, by making changes to task timings and allocations and by selecting from pre-planned contingencies. Replanning from first principles is not part of this program. Plans are formed off-line, *a priori*, by human planners using existing military planning techniques. COORDINATORs will solve the online adaptation problem using the aforementioned techniques (adjusting task timings, changing task allocations or assignments, and selecting from pre-planned contingencies). For solutions that fall outside of this space, human input will be required. This will enable COORDINATORs to provide effective support without large amounts of domain knowledge. This will also enable COORDINATORs to operate within the existing military structure by supporting existing processes/procedures rather than replacing them.

Figure 1 illustrates the concept. Currently the military has effective human processes for mission planning that incorporate a wide range of factors from target selection to support logistics. Where coordination technology can pay the highest dividends is in what happens to those static (often paper) mission plans and pre-planned contingencies when the units deploy. Once deployed, the game changes. The units are physically distributed, authority is distributed, and information is distributed. When change occurs the units must gather and exchange the change information, evaluate the implications of the change, generate candidate response options by considering their initial plans / contingencies, evaluate downstream implications of each option, and evaluate the trade-offs of the different options. They must do this in a distributed setting and generally do this using radios to communicate with each other and up/down the chain of command. When humans perform this coordination, the results are error-prone, suboptimal, time consuming to produce, and the process of coordination itself incurs great cognitive load. The key issue is that it distracts the human units from focusing on the big picture and from focusing on the enemy, and divides their attention between the high-level tasks (at which humans are proficient) and the low-level information exchange and analysis.

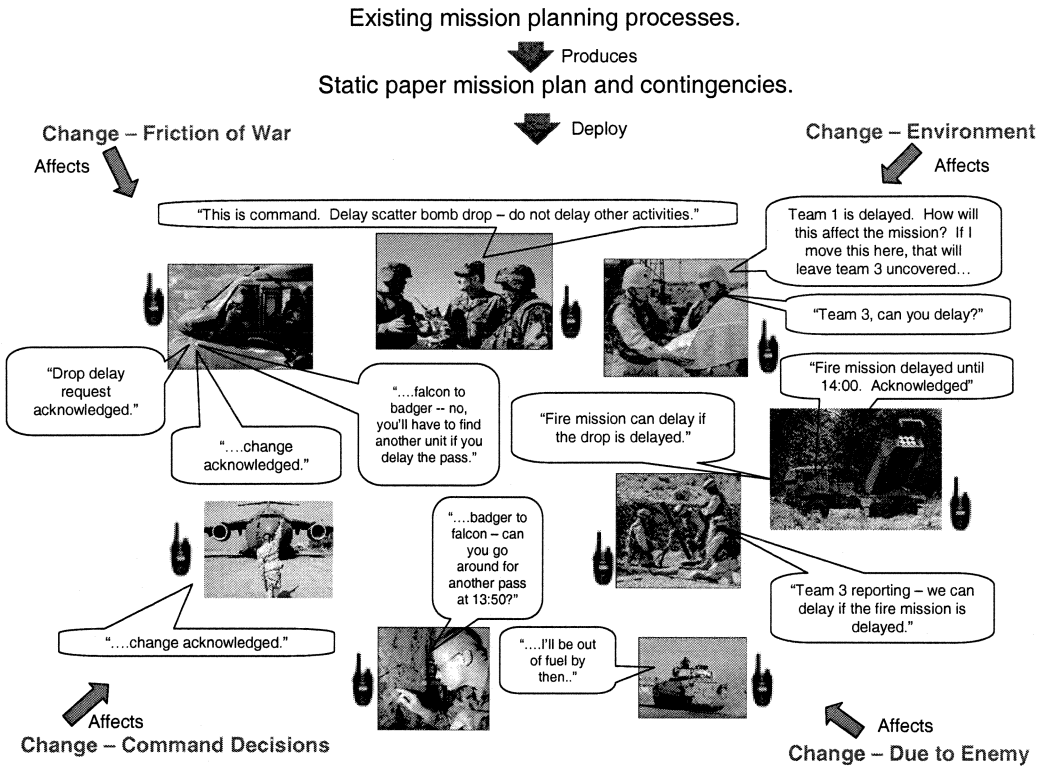

Figure 1 - Today Coordination Is Manual And Distracts Human Units

Our goal is to replace human labor with COORDINATORs / cognitive coordination managers, as shown in Figure 2. With intelligent support, responding to change will be fast, precise, and not labor intensive. The humans can focus on managing the high-level picture while the COORDINATORs handle information exchange, reasoning about the implications of change, option generation, option evaluation, and over time, even learning to make decisions for the human user when he/she is occupied with other tasks.

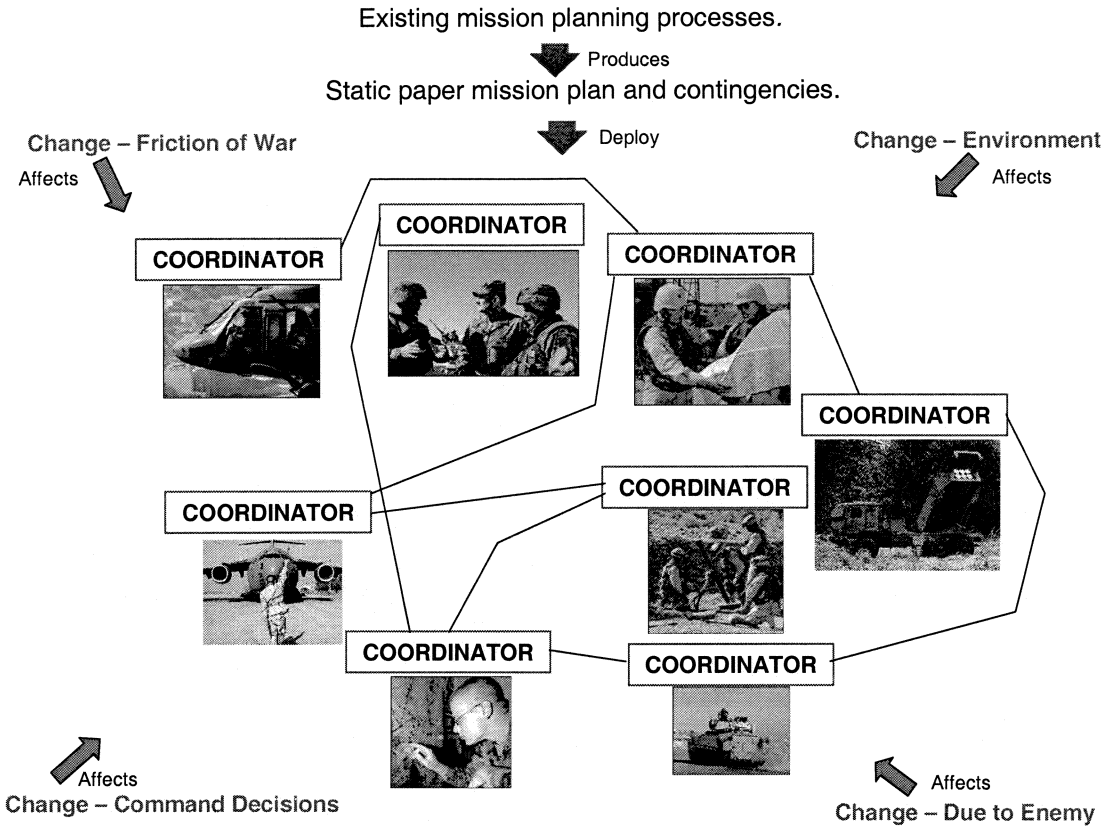

Figure 2 - With COORDINATORs Humans Can Focus On The Big Picture

COORDINATORs are about making sure the right tasks are performed by the right people, at the right times, for the current and *changing* circumstances.

To better understand the anticipated role of COORDINATORs, imagine a fielded human unit, e.g., a solider, coupled with a COORDINATOR running on a wearable computing platform. The soldier's COORDINATOR will use wireless networking technology to interact with the COORDINATORs of other soldiers to coordinate their actions. The COORDINATORs will do this by reasoning about both individual and joint action – the tasks assigned to their respective units and the temporal constraints placed on the tasks (e.g., deadlines), and how the tasks of their units interact with the tasks of other units. Note that this program is not concerned with developing new device technology or with developing new networking technologies. The necessary infrastructure either exists or will be developed elsewhere.

The term *coordination* is sometimes subject to broad interpretation. This program is not about collaboration in general rather about managing the interdependencies between the activities of different distributed parties. To illustrate the class of problems and DARPA's interest in this problem, let us consider a **hypothetical** example.

In this scenario, a political hostage is captured by a terrorist force. If the demands of the terrorists are not met by time *T*, the hostage will be killed. Intelligence indicates that the

hostage is being held in one of six different locations – three land facilities and three oceangoing vessels. One possible military response is to set up a joint forces headquarters and to engage in a multi-service synchronized strike against all six targets. For the purpose of this example, we will assume this is the case. The synchronized strike is necessary because the hostage's exact location is unknown and if the different sites are forewarned they could move the hostage, kill the hostage, or be better prepared. For this mission the military deploys a company of Army Special Forces (SF), a platoon of SEALs (Navy), four Navy MK-V boats, a detachment of Air Force MH-53J troop transport helicopters, and two Air Force AC-130U gunships.

The high-level strike plan is shown in Figure 3. The Air Force MH-J helicopters will take the SF units to their respective drop points and return to base. The SF units will move into position while the SEAL teams also move into position. When all the teams are ready, they will engage. Concurrently with this the Air Force gunships will fly patterns over the region ready to lend fire support as needed.

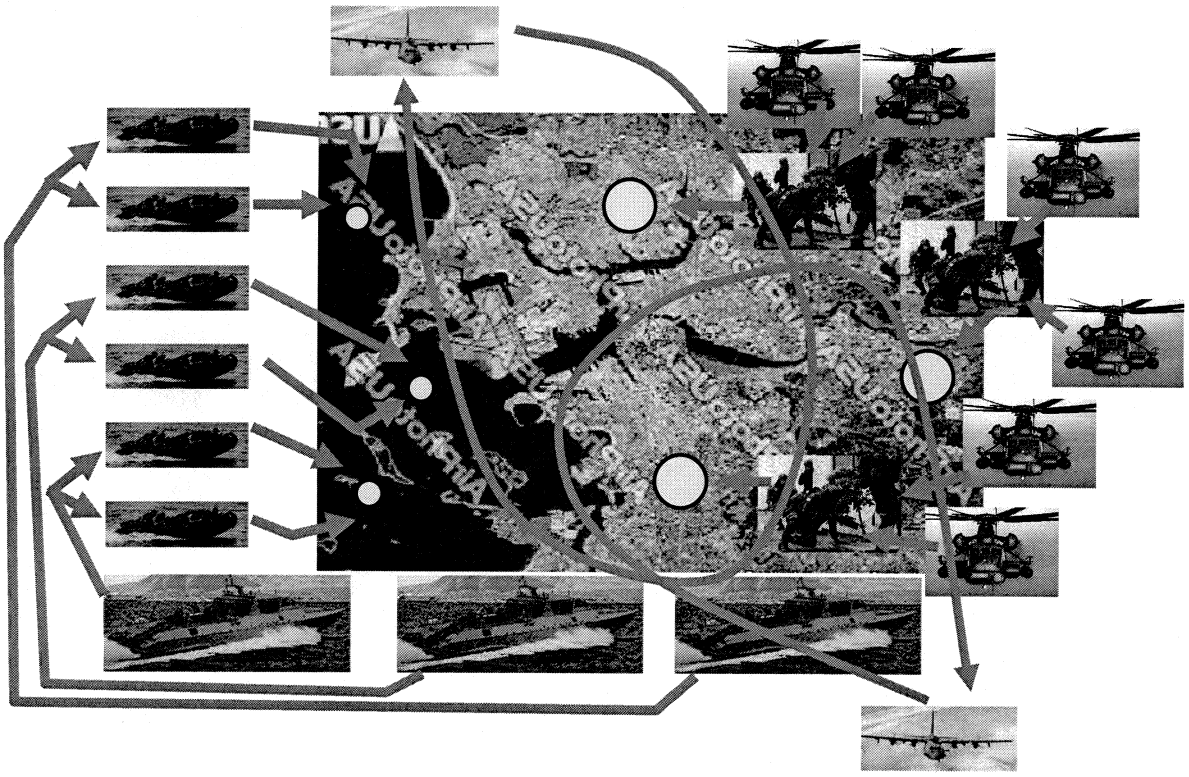

Figure 3 - High-level Strike Plan For Hostage Rescue Mission

Figure 4 shows what happens to the mission from a planning perspective. The initial mission plan is formed off-line, *a priori,* using intelligence, experience, and assumptions about how the enemy will be configured and will respond. The military has many heavyweight and effective planning processes and procedures for forming the initial plans. The output of the planning process is a set of static mission plans and a set of pre-planned contingencies. These plans are then deployed in a dynamic environment and the game changes.

After deployment, change occurs and impacts the mission – change from friction of war, the environment, the enemy, and even from command decisions. The distributed units must respond to the change online, in real-time, by adapting their mission plans and often the response is to make changes to task timings, allocations, or to select from pre-planned contingencies. This is the focus of COORDINATORs – online plan adaptation. COORDINATORs make sure the right tasks are performed by the right people at the right times for the current and changing circumstances.

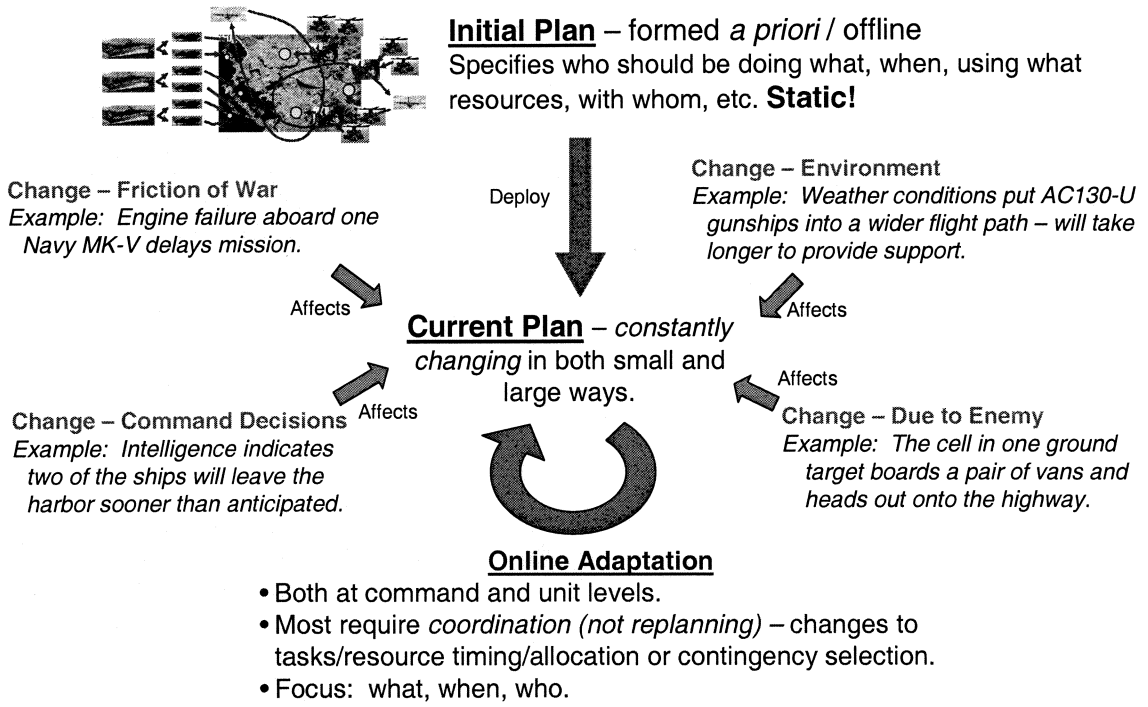

Figure 4 - The Mission Planning Process Through The Mission Life-cycle

Returning to the mission, Figure 5 shows a high-level view of the task interconnections and timings of the mission. Note that not all the team activities are spelled out or fully broken down. The general flow is that the MH-Js drop the SF teams and return to base. The SF teams move into position and when they are in position they deploy their sniper-observer units. At that same point (the land/sea operations synchronization point), the Navy SEALs, who have concurrently been moving into position on their MK-V boats, are deployed on their CRRCs (rubber rafts) to make their way stealthily toward their targets (deployment times are staggered based on distance to target). When all the teams are in place, they engage. The scheduled time for engagement is called *H-hour* and that synchronization point is also identified in the figure. Note that the teams engage before *T,* the time at which the hostage is to be killed.

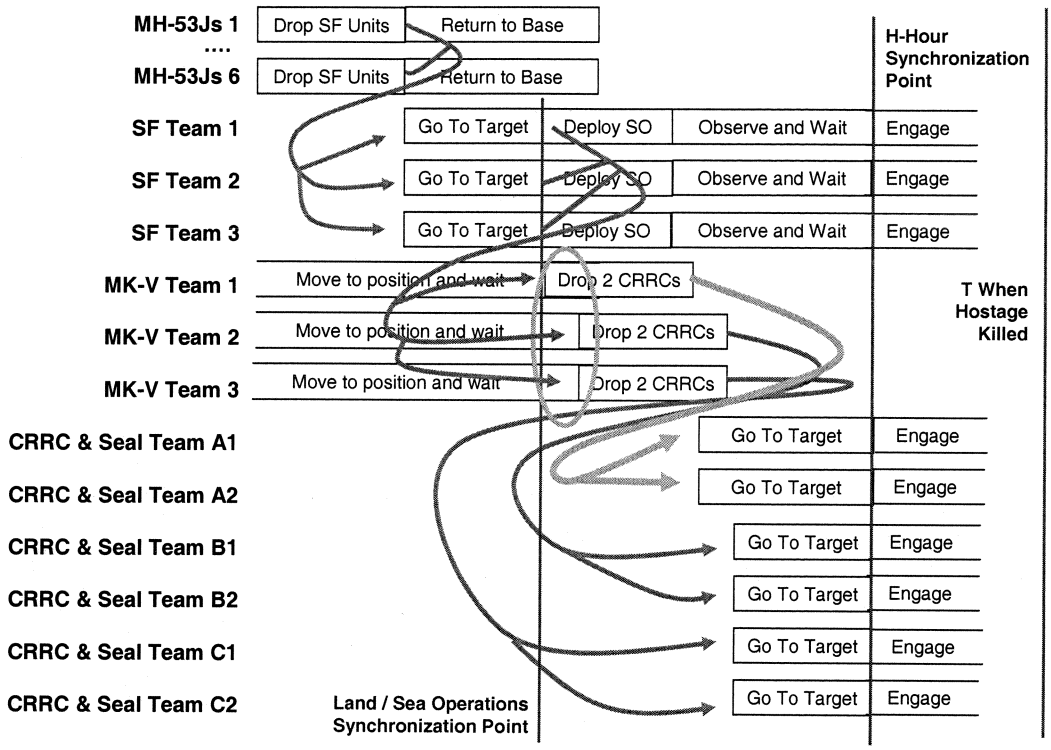

Figure 5 - The Initial Plan

Figure 5 shows the plans as they are formed off-line / *a priori*. Once the teams are deployed of course, change occurs. What happens if SF team 3 is delayed, as shown in Figure 6? Today the teams must manually exchange information (the delay) and reason about the implications of any change being considered. With COORDINATORs this process would be automated. In this example, the COORDINATORs could handle the information exchange, reason about the interactions between tasks, analyze the implications of the delay, and suggest a change (eventually learning to make the decisions autonomously when appropriate). In this case, they would flag the affected tasks, and recommend a right-shift, as shown in Figure 7. Note that the scope of the change in this case is limited – all the teams have to do is to move the two land/sea operations synchronization points and they can still engage the targets before time *T*. The revised timings are shown in Figure 8. For large efforts, however, the information exchange, analysis, and option generation processes can be non-trivial.

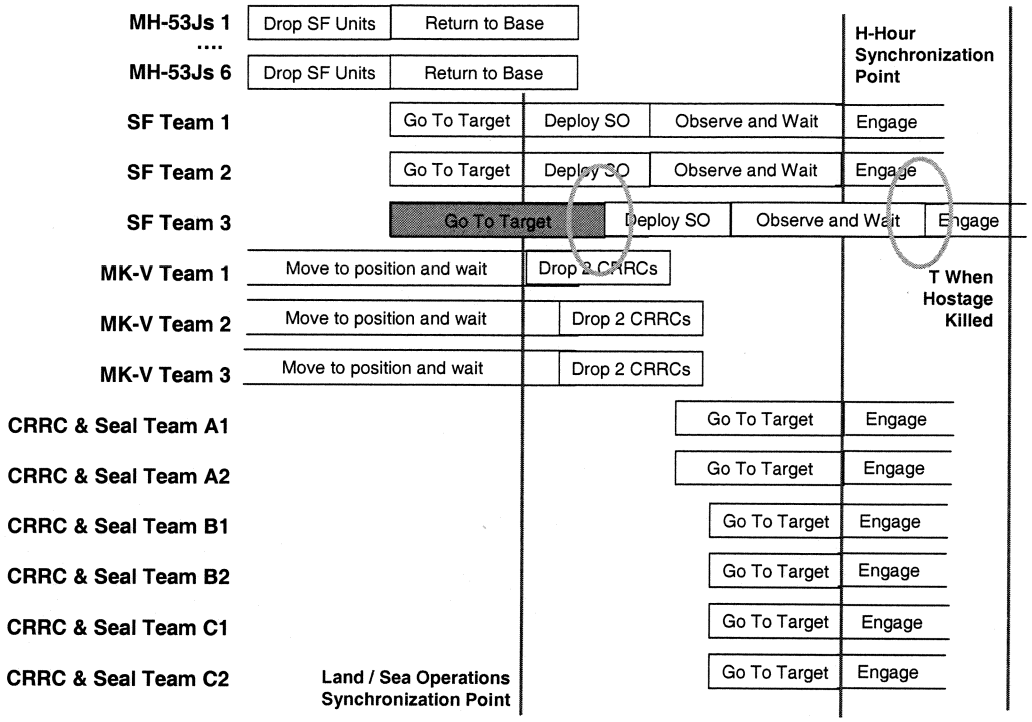

Figure 6 - SF Team 3 Is Delayed

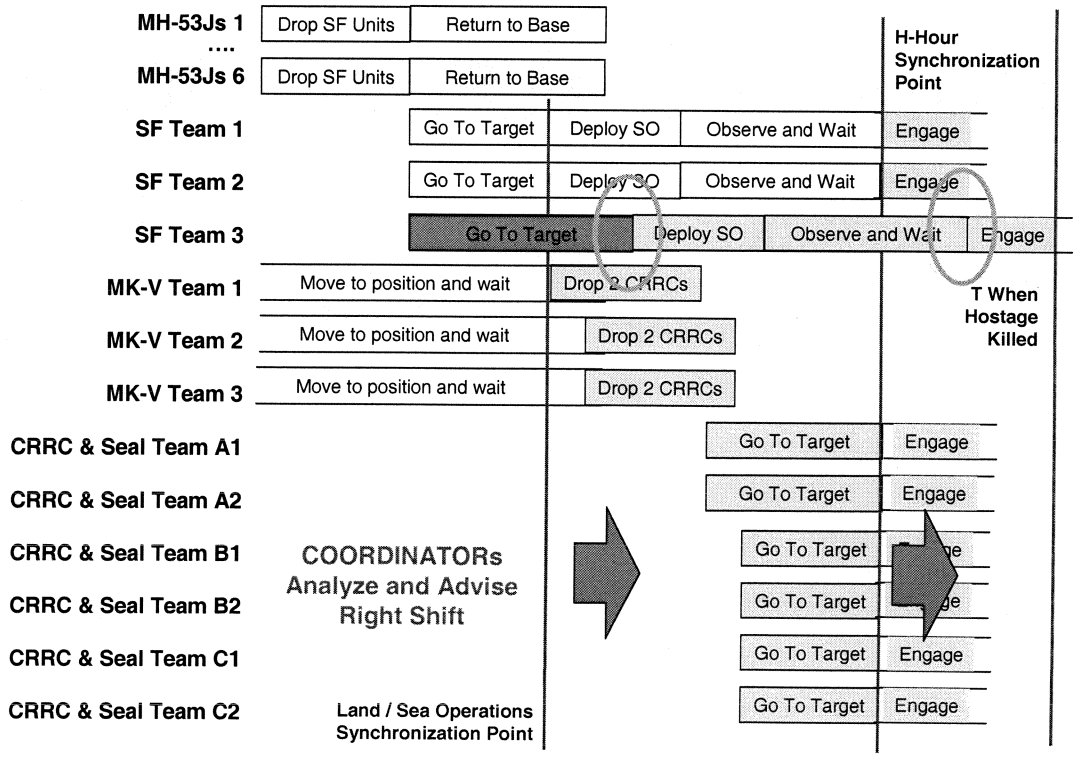

Figure 7 - COORDINATORs Analyze The Change And Suggest Revised Timings

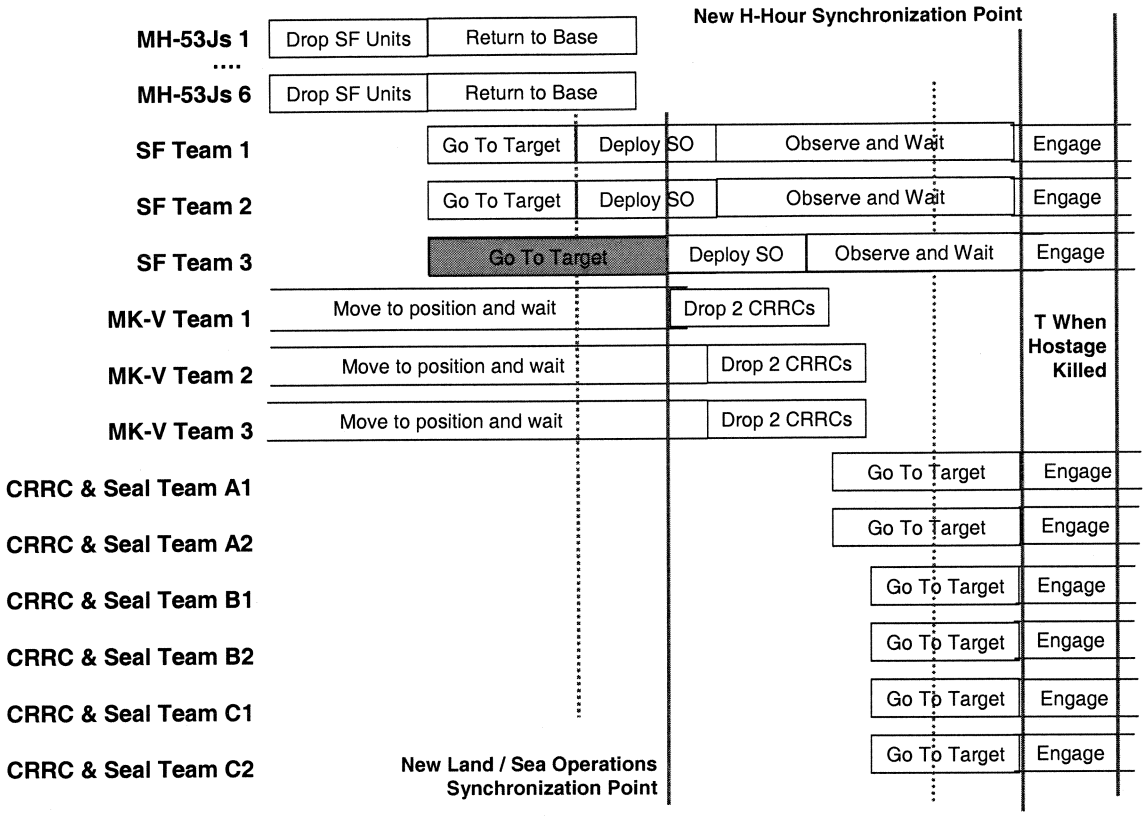

Figure 8 - Mission With Revised Timings

Now assume another change occurs – new intelligence indicates that one of the ships is preparing to leave harbor sooner than anticipated. In response, command asks the question "What happens if we move H-hour sooner?" Again, COORDINATORs could replace the manual analysis and situation verification from all the distributed units. In this case the affected tasks would be evaluated and, as shown in Figure 9 and Figure 10, the COORDINATORs could select from pre-planned contingencies to step-up the tempo of operations. The key change being that instead of deploying the SEALs on their CRRCs the SEALs would speed directly to their respective targets on the MK-V boats and deploy.